

LABOR and EQUIPMENT for FEEDING SILAGE

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On the cover.....

Considerable thought must be given to correlating the feeding facilities with the location of the silo. Here cattle are being fed in bunks some distance from the silo.

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SUMMARY

The development and use of efficient forage harvesting methods have changed but not eliminated silage handling problems. Removing, transporting and feeding become more important as greater volumes of the forage crops are preserved in the form of silage. Self feeding from horizontal silos is a relatively new labor saving development. Self feeding is not practicable on all farms.

Labor and equipment costs of removing and feeding silage from various silo structures were studied. The study disclosed that the following factors need to be considered in selecting a feeding method.

All types of cattle—dairy cows, replacement stock, beef cows and feeder cattle were satisfactorily fed by all methods of removal and feeding studied. (Hand methods, mechanical equipment and self feeding.)

Methods of feeding were related to the amounts of silage fed per day. Farmers feeding 500 to 800 pounds per day from either horizontal or upright silos used hand methods aided by inexpensive equipment (fork, scoop or cart). When 1000 to 1500 pounds of silage were fed per day more power and equipment were used. Self feeding became increasingly practicable when larger amounts, around 2000 pounds were fed per day.

Location of the silo to the feeding area may be dictated by the location and layout of existing structures. Some farms had feed lots, and storage structures located so the silage had to be moved some distance. Other farmers were able to arrange facilities so that little transportation was required. The livestock went to the silo on farms with self feeding arrangements.

Labor time and cost were correlated with the method employed for feeding silage. Self feeding had the lowest labor cost per ton fed. Mechanical silo unloaders used in upright silos did not always reduce the labor but did minimize physical effort. The cost of owning and

¹Investment and annual storage cost of silage in upright, trench, bunker, stack and temporary silos will be presented in another publication.

using mechanical unloading equipment is high. Generally the larger the quantity of silage fed per day, the greater the quantity of equipment used. Exceptions to this were farmers transporting silage to several feeding locations at distant points.

Waste was much greater in self feeding than with any other method. Horizontal silos had greater spoilage losses than upright silos because of the large surface exposed.

A **paved floor**, approaches, and feeding lot areas are necessary for satisfactory horizontal silo operation. In unpaved yards and silo floors, contamination and mud increased the expense and difficulty for livestock and equipment to move in and out of the silo.

Low labor and equipment cost generally resulted under ideal conditions with self feeding from horizontal silos. With the varied conditions found in practice, some farmers will find it more practical to do hand feeding or to adopt various degrees of mechanization.

INTRODUCTION

Ohio farmers harvested, preserved and fed over two million tons of silage last year. Corn silage comprised one and one-third million tons and grass-legume mixtures two-thirds of a million tons. Similar quantities of corn silage have been fed in Ohio for the past 30 years. Grass-legume forage mixtures harvested for silage increased from 83 thousand to two-thirds of a million tons during the past 5 years.

Making, storing and feeding the forage crops as silage requires heavy work and considerable investment in facilities and equipment. Many different methods of feeding silage and several different types of storage structures are in use in Ohio.

Storing and feeding of grass-legume silage became practical with the development of efficient field forage harvesting equipment and the development of horizontal silos. Reduced weather risk, higher quality feed with more palatability, greater emphasis on the use of forage crops and lower costs are frequently cited as reasons for the preservation and feeding of forages as silage. Labor and equipment costs became more important as larger volumes of silage were preserved and fed.

Some farmers felt the labor saved in harvesting and storing was frequently offset by the labor required for the removal and feeding operation. Consequently, farmers developed more efficient and easier ways to handle and feed silage. Farm situations differ and the feeding operation must be tailored to fit the farm and the farmer for maximum efficiency.

METHOD OF STUDY

Farm operators were contacted and information secured on factors affecting the efficiency of the silage removal and feeding operations during 1956. Horizontal and upright silo storage and construction costs were studied during 1955 on 110 Ohio farms. Thirty-eight of these farms were visited again during the 1956-1957 feeding period for intensive study of the removal and feeding operation.

Eighteen farmers were self feeding from horizontal silos and 20 were using hand and mechanical feeding equipment. Detailed information pertaining to the removal and feeding operation was obtained from each operator. Data were collected on capacity and dimensions of the silo, rate of silage consumption, labor, facilities, and numbers and types of livestock. Labor and equipment costs were budgeted at standard rates.

Time and motion studies were conducted on each of 20 farms using some mechanical or hand equipment for the removal and feeding of silage. A stop watch was used to obtain the normal rate of work performance for each phase of the operation. Man and equipment travel distance was measured. Operators were asked to perform each task in their usual manner and not to work faster or slower or to talk with the observer.

Original data from a 1950 dairy chore labor were re-examined for information relative to feeding silage from upright silos.² Variations in quantities fed per day, number of cows, equipment and labor used were summarized and compared.

SELF FEEDING FROM HORIZONTAL SILOS

Self feeding from horizontal silos has advantages because of the modest investment and low labor requirement. Fifteen bunker (above ground) and 3 trench (below ground) silos were included in the 18 silos where self feeding was used.

Number of Animals Fed per Silo

Livestock	Number of farms	Number of Animals	
		Average	Range
Dairy	6	24	16-135
Feeder cattle	9	95	30-230
Beef cows	3	58	53- 60

²Baker, R. H. and R. A. Bailey—"Plan Dairy Chores", Ohio Agricultural Experiment Station, Research Bulletin 706, March '52, Wooster, Ohio.

Number of animals and length of the feeding period were determined by the dimensions of the silo.

Common Silo Dimensions

Length	Width	Depth
80 feet	20-22 feet	6 feet

Typically a silo of this size held 165 tons of which 140 tons were consumed. The remaining 25 tons spoiled or were wasted.

A barrier was used to control the amount fed per day and to prevent the livestock from walking on the unconsumed silage. Fifteen farmers used a wooden hurdle or feeding gate. Experienced feeders preferred a hurdle with a solid panel at the bottom and vertical slats.

Feeding Hurdles

Sections per silo	Width	Height	Slats spacing	Height of panel
1 or 2	Silo width	5 feet	12 to 14 inches	20 to 24 inches

One-half of the feeders used a single hurdle the full width of the silo. Others used 2 sections and 1 man, 3 sections. None of the hurdle sections exceeded 22 feet in width. Bottom panels reduced waste by forcing the livestock to eat more of the silage without pulling their heads out and by minimizing contamination.

Hurdles were usually constructed to stand alone. A foot fastened at a right angle was braced to withstand moving and abuse. One-third of the feeders used a rope or brace at the top to support and control the movement of the hurdle by the cattle. One man could easily move most of the feeding hurdles. Actually the cattle did much of the moving by pushing against the feeding hurdle.

Three farmers used "hot" wires to self feed the silage. The wire was placed 20 to 30 inches above the floor, fastened to insulators at the sides of the silo. One feeder attached the wire to a movable wooden frame. Some of the feeders using hurdles had previously used "hot" wires. Waste and the cattle getting on the top of the silo and destroying the seal were common difficulties.

A wooden feeding hurdle for the typical silo cost \$25.00 to construct. Annual costs of these hurdles averaged \$3.33 per silo of which \$2.50 was for depreciation and 83 cents was for interest, taxes and insurance. Feeders using "hot" wires had an average annual cost of \$5.66 per silo of which \$3.00 was for a battery and \$2.66 for interest, taxes, insurance and depreciation.

TABLE 1.—Costs of Self Feeding Silage from Horizontal Silos with Hurdles, Ohio, 1956*

Farms	Minutes per ton	Costs per Ton			
		Equipment	Waste	Labor†	Total
15	12.6	\$.024	\$0.52	\$0.21	\$0.75

*Based on 140 tons of silage consumed.

†Labor at \$1.00 per hour.

Spoilage occurs irrespective of feeding method. Establishing a seal requires a blanket of silage which deteriorates. A blanket of the same thickness spoils regardless of the depth of the silage in the silo. Losses from spoilage average 8.6 percent of the total silage stored in all horizontal silos.

Waste will occur in all methods of feeding but in self feeding from horizontal silos, waste averaged 6 percent of all silage stored. Losses from waste occurred from: (1) animals pulling silage through the feeding devices and (2) contamination with manure and mud seeping into the silage.



Fig 1.—Some farmers used 'hot' wires to keep animals out of the silage. Others use movable wooden frames as shown in the background here with some attaching wires to these barricades.

Waste must be considered as a cost of the feeding method. A silo with a 165 ton capacity, when self fed, lost an average of 10 tons of silage. Valued at \$7.25 per ton; the cost of producing, harvesting and storing, this loss amounted to 52 cents per ton fed. Wastage losses resulting from other feeding methods were small and difficult to measure.

Labor for the entire self feeding operation averaged 12.6 minutes per ton fed. The labor cost per silo averaged \$29.40. A third of the labor time was for travel to and from the silo and for moving the barrier. The remaining labor was used for removing spoilage, manure, wasted silage and forking down silage.

A direct relationship exists between the tons of silage fed and the time required per ton. Farmers self feeding 50 tons each year used an average of 25 minutes per ton. Slightly more than 6 minutes per ton were required when 250 tons were fed. (See Chart 1.)

**Minutes
per ton**

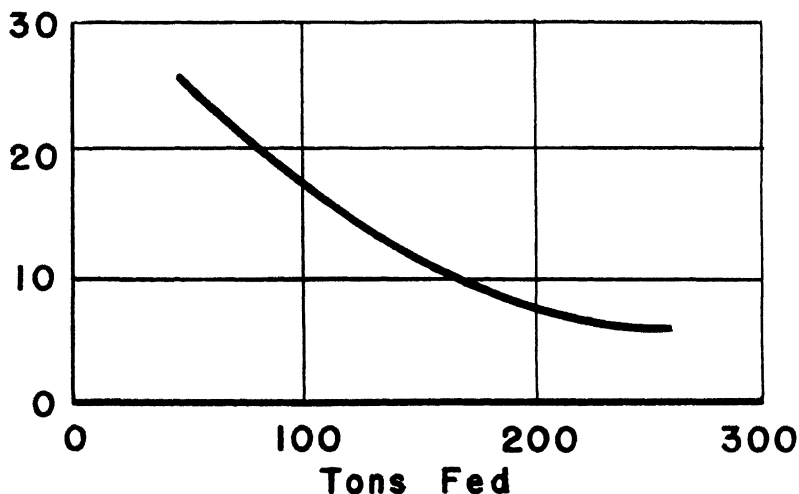


Chart 1.—Labor required to feed one ton of silage from self feeding horizontal silos by tons fed, Ohio, 1956.

Self feeding silage was found to work very well for all types and classes of cattle. Feeding space per animal was important for efficient self feeding. The number of livestock fed and amount of spoilage in the opened feeding area was related to the width of silo. Type and size of cattle that were self fed varied among the farms visited.

TABLE 2.—Width of Feeding Space per Animal in Self Feeding Silos, Ohio, 1956

Class	Number of silos	Inches of silo width per animal	Number of animals per 20 feet of width
Dairy cows	6	7.1	34
Beef feeders	9	4.2	57
Beef cows	3	4.6	52

Dairy cows were provided with more width per animal than for feeder cattle or beef cows. Usually the dairy cows were larger and did not have access to the silage 24 hours per day. Feeder cattle had been observed eating at night. Weight of feeder cattle average 625 pounds and ranged from 500 to 800 pounds at the time of the visit. The farmers felt this feeding space would be adequate for these animals until market time. Operators with 50 feeder cattle or fewer allotted 5 inches while those with more than 100 head allotted 3.5 inches per animal.

Rate of silage consumption varied with the type and size of animal and with the quantities of other feed provided. Some feeders controlled the amount eaten per day, others permitted the cattle to consume what was desired. Cattle cleaned up all of the silage when forced to, however, dairy farmers experienced a drop in milk production when fresh silage was not available at all times.

The feeding period was directly related to the silo length. Generally the feeding period in days was twice the silo length in feet. The typical 80 foot silo had a 150 day feeding period. Spoilage was minimized when about 6 inches or more of length was removed each day. Effective feeding width of some silos were doubled by feeding from both ends at the same time.

Depth of silage was important for efficient self feeding. Six feet of settled silage was optimum. Cattle could not reach over 6 feet high. Spoilage losses were smaller in silos with greater depths but additional

labor was required for forking down silage. Spoilage losses were greater in shallower silos and more labor was required for removing spoiled silage and moving the barrier.

Farm operators using self feeding horizontal silos expressed the opinion that a solid, well drained floor is a necessity. Some feeders had used silos with earth floors and emphasized the importance of a paved floor under adverse conditions. The floors were concrete in 16 silos—one silo had an asphalt blacktop floor and one had a gravel floor. Without a solid floor the livestock stood in mud and silage losses were greater.

Four farmers had drainage difficulties and stressed the need for sloping the floor. One man using self feeding silos for several years, stated that he would make the floor high in the middle and drain 4 ways—to the sides as well as to the ends.

Ten feeders reported difficulties with mud, manure and drainage in lots surrounding the silo. These operators felt this problem could be eliminated by paving or graveling more of the feed lot area.

Boss cows were a minor difficulty. Most of the cattle were dehorned or were polled. One operator had not dehorned and reported difficulties with the horns.

Two feeders had a problem with frozen silage. Freezing took place at the top of the silo and had to be broken loose to permit movement of the barrier.

HAND AND MECHANICAL FEEDING FROM HORIZONTAL SILOS

Labor, travel and equipment were studied on 20 farms where different removal and feeding systems were used. Silo structures were similar to those used for self feeding. However, the number of animals that could be fed and the rate of removal did not depend upon the silo width. Depth of the silage could be as great as removal equipment would handle efficiently. Percent of spoilage decreased as the depth of the silage increased.

Man labor used for feeding was checked with a stop watch. Travel for men and equipment was measured and recorded for each farm. Labor and equipment used in getting ready, moving to the silo, removing silage, loading, transporting, feeding and returning were included in the feeding operation.

Most of these farmers fed silage once each day. All classes of dairy and beef cattle were fed by these methods.

Tractor manure loaders eliminated much hand labor. Manure loaders were used to remove, transport and dump silage directly into feed bunks. Feed bunks were placed near the silo to minimize time and travel. Most of the travel was for moving equipment to the silo and returning after completing the feeding chore.

These feeders moved an average of 343 pounds of silage per scoop. Six of the 7 feeders averaged 4 scoops per feeding and used 13 minutes to complete the operation. These men fed 106 pounds per minute or at the rate of a ton in 19 minutes. One large feeder averaged 5500 pounds with 15 scoops per feeding. This man traveled 4950 feet with a tractor and walked 120 feet. He fed at the rate of 149 pounds per minute or a ton in 13.5 minutes.

The tractor manure scoop method of feeding required considerable equipment investment. A tractor with a mounted manure loader was tied up during the feeding period. None of these feeders purchased this equipment exclusively for feeding silage.

The use of a tractor was figured at \$1.20 per hour, man labor at \$1.00 per hour, manure loader at 30 cents per hour and the annual cost of 2 feed bunks at \$11.67. (See Table 4).

TABLE 3.—Silage Fed, Feeding Rate and Distance Traveled by Selected Hand and Mechanical Feeding Methods, Horizontal Silos, Ohio, 1956

	Number of farms	Pounds fed per day	Feet traveled		Pounds per minute	Minutes per ton
			Tractor	Man		
Tractor manure loader	7	1913	1737	147	114	18
Hand fork to bunk	4	762	----	1236	78	26
Hand fork to self feeding wagon or cart	4	1788	1281	142	53	38
Hand fork to wagon or cart and hand fork to bunk	5	1665	3359	270	40	50

Forking silage by hand into a feed bunk located in or at the side of the horizontal silo was done on 4 farms. Only 1 or 2 steps were taken in moving the silage and very little equipment was needed. The typical equipment consisted of a fork and a feed bunk. This method was efficient in the use of labor when small quantities were fed per day. Most of the feeding cost was for labor.

Feeders short of capital and with an ample strong labor force should consider this method for feeding small quantities of silage. The fatigue of feeding large amounts per day would be great, making the use of more equipment desirable.

TABLE 4.—Labor and Equipment Cost per Ton of Silage Fed, Selected Method of Removal and Feeding, Ohio, 1956

	Number of cases	Tons fed per silo	Cost per Ton		
			Equipment	Labor	Total
Tractor manure loader	7	134	\$0.52	\$0.29	\$0.81
Hand fork into bunk	4	57	0.09	0.44	0.53
Hand fork to self feeding wagon or cart	4	134	1.22	0.63	1.85
Hand fork to wagon or cart and hand fork to bunk	5	125	1.29	0.83	2.12

Self feeding wagons or carts were backed into the silo, loaded by hand and pulled to a desired location for the cattle to feed. Specialized feeding wagons were in use for the feeding season and a tractor was



Fig. 2.—Self feeding carts such as the one shown here are often backed into the silo and filled and then moved to the feeding area. Costs are higher but a more flexible feeding program is possible.

needed for a short time each day. Equipment and labor costs were fairly high but considerable flexibility of the feeding operation was possible. The silo could be located some distance from the feeding area with this method.

The rate of feeding was less than half of that achieved by farmers using manure loaders. Equipment and labor costs were more than double that of feeders using manure loaders for slightly smaller quantities of silage fed per day.

Hand forking silage on and off a wagon was studied on 5 farms. Silage was usually fed at more than 1 location and some feeders used as many as 4 feeding locations. Average quantities of silage fed were less but travel was about double that on farms where manure loaders or self feeding wagons were used.

Feed bunks, a wagon or trailer of convenient size, a fork, a tractor and a large amount of man labor are required for this system. Labor and equipment costs were highest with this system. Feeders using this method were able to fit the horizontal silo into the existing feeding facilities. Reorganization and rebuilding of feeding facilities were minimized but efficiency in the use of labor and equipment was low.

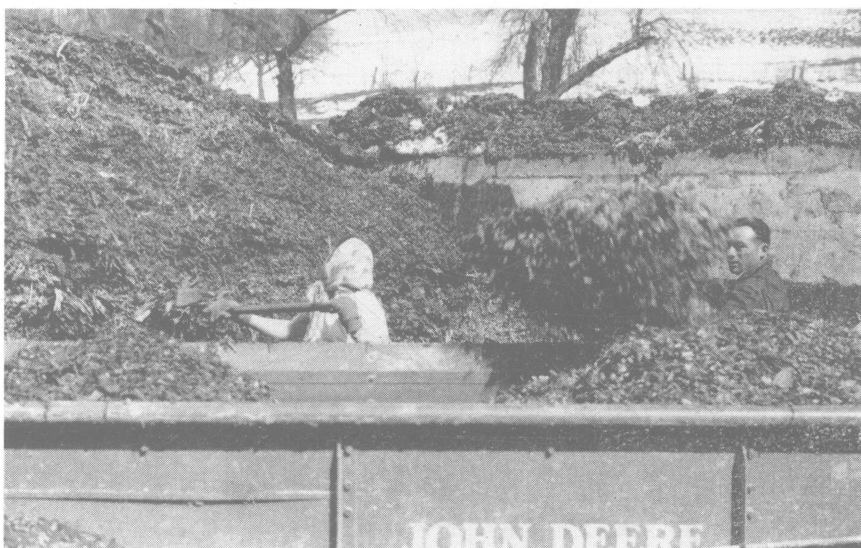


Fig. 3.—Farmers hand loading wagons fed less silage but had more travel and labor than when loaders or self feeding wagons were used.

Location of the horizontal silos greatly affected the efficiency of the feeding operation. In some cases insufficient thought had been given to the selection of the silo site with respect to the feeding location. Frequently desirable silo sites were found at some distance from the center of the feeding operation. The erection of a silo at such a site minimized construction costs but usually increased the labor, equipment, travel and cost of handling and feeding silage. Over several years the physical effort and additional feeding cost would offset additional construction cost of a silo on a less than an ideal location. On some farms the cost of completely reorganizing the feeding arrangements would be justified.

A paved silo floor and feeding area was necessary for satisfactory operation. In all of the methods of feeding studied, livestock or equipment and men had to move in and around the silo. During part of the silage feeding season severe difficulties were experienced on farms that did not have well drained, paved or graveled silo floors, approaches and feed lots.

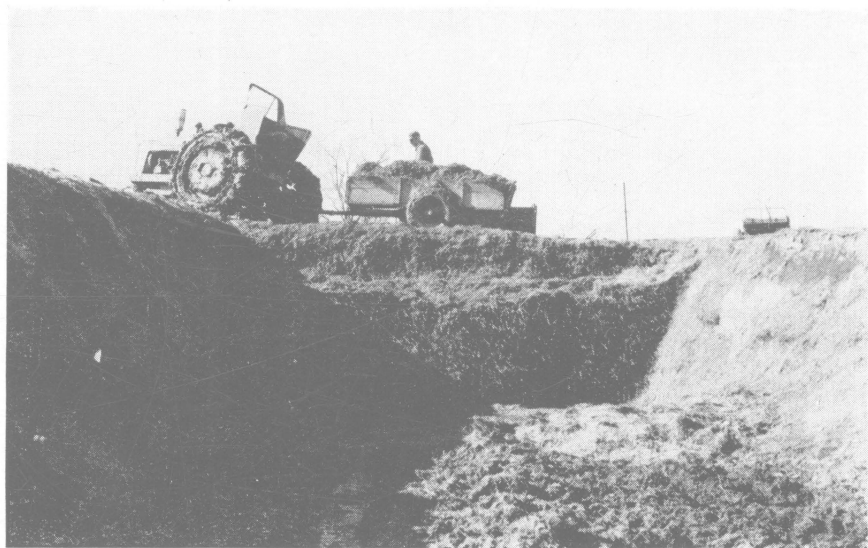


Fig. 4.—During part of the season difficulties are experienced if the silage floor is not paved and well drained.

FEEDING FROM UPRIGHT SILOS

Complete time and motion studies of dairy chores were made on 15 dairy farms during 1950. Labor and equipment used for the hand removal and feeding of silage were studied as a part of the dairy chores.

Hand removal from upright silos is the most common method in use today. Some farmers have installed automatic unloading equipment or have purchased silos with bottom unloaders. A few self feeding upright silos are in use.

Automatic distribution and feeding facilities have been built and used by a few farmers. Reciprocating type gutter cleaners, false bottom carts, elevators, lazy susans, endless chains and webs have been used for self feeding from upright silos. Feed bunks located at the base of the silo chute reduce feeding labor.

Method of hand removal and travel distance was similar on the farms visited. Quantities of silage thrown down and fed per day greatly affected the labor efficiency. A man feeding 600 pounds per day traveled about the same distance in getting to the silo, climbing up and returning as a man feeding 850 pounds. Labor time for throwing down silage varied from 15 minutes per ton to 30 minutes per ton, depending on the quantity fed per day.

After the silage was in a pile at the base of the silo, 3 methods were used to transport and feed it to the livestock. Farmers used carts, baskets or tubs and scoop shovels to transport and distribute silage. Labor efficiency varied with the barn layout, distance the silage had to be transported and the equipment used.

Four farmers used a milking parlor and loafing barn, feeding the silage in the loafing area. The other 11 farmers fed silage in stanchion barns.

TABLE 5.—Labor and Travel for Throwing Down and Feeding from Upright Silos, Selected Methods, Ohio, 1956

Equipment	Number of farms	Cows per farm	Pounds of silage	Feet of travel	Feet of travel per 100 pounds	Pounds per minute	Minutes per ton
Cart	3	22.5	850	331	39	56	36
Basket or tub	7	17.5	804	763	95	50	41
Scoop	5	19.5	613	1065	174	40	49

Silage carts enabled feeders to reduce travel to 1 or 2 trips. Equipment cost was slightly higher (averaging \$75 per farm) but labor costs were lower with carts. The feeders using carts fed more silage per day but used less labor than when the silage was transported with baskets, tubs or scoop shovels.

Feeding silage with a basket or tub has been one of the most common methods used for feeding from upright silos. Equipment costs were low but more labor was required. Total costs per ton fed for the removal and feeding was similar to those experienced by feeders using carts. The most important difference was in man labor.

TABLE 6.—Labor and Equipment Costs for Feeding Silage from Upright Silos by Selected Methods, Ohio, 1956

Equipment	Number of farms	Tons fed	Cost per Ton		
			Equipment	Labor	Total
Carts	3	69	\$0.16	\$0.60	\$0.76
Tub or basket	7	60	0.06	0.68	0.74
Fork and scoop	5	46	0.07	0.82	0.89
Bunk located under chute	(estimate)	70	0.09	0.42	0.51

A **scoop shovel** was the basic equipment used on 5 farms for distributing and feeding silage. These herds were smaller and were fed less silage per day. Equipment costs were low but man labor costs were high because more labor was required. The distance traveled to feed 100 pounds was more than 4 times that required on farms using carts. The 13 minute per ton difference between farms using scoops and carts would amount to 22 hours of work for 100 tons of silage. More important than the labor time saved is difference in the distance walked and the physical effort expended.

A **feed bunk under the silo chute** is efficient when the silo location, feed lots and the handling of cows make it practical.

Many silos are not favorably situated for feeding without transporting the silage some distance. Silos situated so that silage can be dropped in the end of the feeding bunk require a minimum of labor for distribution. Labor for throwing down silage would be similar to that for any upright silo from which similar quantities were fed per day.

TABLE 7.—Labor and Equipment Costs per Ton for Removing and Feeding Silage from Upright Silos by Selected Methods, Ohio, 1956

	Tons of Silage		
	50	100	150
Carts	82¢	71¢	67¢
Basket or tub	76	72	71
Fork and scoop	89	85	84
Bunk under chute	55	48	46

Removing silage from an upright silo required approximately 20 minutes per ton. Distribution labor was estimated at 5 minutes per ton fed. Equipment consisted of a feed bunk and forks.

The equipment was related to the quantity of silage fed each season. Farmers feeding small amounts of silage invested less in equipment. Usually labor was not a limiting factor and the equipment cost was spread over a small tonnage. On farms feeding larger quantities of silage there was greater pressure to save labor and opportunities to spread costs for equipment over more tons. (See Table 7).

Farmers moving silage shorter distances from the base of the silo to the feeding location tended to use smaller units, such as scoops and baskets. On farms moving silage greater distances the advantage of carts and fewer trips was realized.

MECHANICAL SILAGE UNLOADERS³

The removal of grass silage by surface unloaders in upright silos was studied during 1956 by the Agricultural Engineers. Ownership and operation costs such as depreciation, interest, taxes, insurance and repairs were based on reports from 24 farmers.

Grass silage was unloaded at an average rate of 33 pounds per minute or 1 ton per hour. Unloading rates varied from 9 to 50 pounds per minute for the actual unloading of the silage. Repairs, lubrication, inspection and other maintenance time was in addition to the unloading time. Approximately 1 in 5 operators stayed with the machine during the unloading operation. Some of the men staying with the machines

³Asmus, Rodger W., "Silo Unloaders on Ohio Farms", Agricultural Extension Service, Ohio State University, Bulletin 360, April, 1957, Columbus.

filled a cart while waiting for the unloading to be completed. The others started the machine, then left to do other chores and returned at the end of the unloading operation.

The cost of equipment for transporting, distributing and feeding must be added to the labor and equipment cost of the unloading for comparison with other methods. Cost of owning and operation of the unloader was greater per ton than for other methods of feeding from upright silos.

The average investment for surface unloaders studied was \$1100.

**TABLE 8.—Annual Equipment Cost per Ton and Unloading Rates for Mechanical Surface Unloaders in Upright Silos
Grass Silage, Ohio, 1956**

Unloading Rate		Cost per Ton Unloaded			
Lb./minute	Ton/hour	100	140	200	300
33	1 0	\$1 55	\$1 18	\$ 99	\$ 92

Farmers using automatic unloading equipment reduced the physical energy required but did not reduce labor time. Men standing by the machine during the unloading operation spent more time per ton than if the silage was unloaded by hand. After unloading, the cost of equipment and labor to distribute and feed would be the same as without unloaders. Some farmers installed automatic silage distribution equipment and automatic unloaders which increased the capital but greatly reduced the hard work.

A few men increased the annual tonnage removed with a mechanical unloader by using the unloader in a second silo. Moving the unloader required some disassembly. Labor required for moving usually took a half day for 2 or 3 men. Use of an unloader in more than 1 silo spreads the fixed costs over more tons of silage but increased the total cost by approximately \$12.00 per year at farm labor values.

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